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Proposal

Development of a SWP/CVP Operations Decision Support System For a Pilot Program Integrating an Environmental Water Account with Flexible Operations based on Real-Time Fish Triggers

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Background-

From about November of 1998 through June of 1999, members of the Diversion Effects on Fishery Team (DEFT) and No Name Group (NNG) Coordination Team (DNCT) under the directives of CALFED's Policy Group have conducted a series of games to evaluate how an environmental water account (EWA) could be operated to provide greater fishery protections on the one hand and improve water quality and water supply on the other. The environmental water account and flexible SWP/CVP operations are devised to be integral parts of CALFED's Interim Program (the next seven years). Members of the DNCT evaluating this approach are composed of regulatory agency and water user biologists, the SWP/CVP operators, engineers and consultants representing a number of environmental protection agencies, water districts and water use groups.

The basic premise of the EWA and flexible operations is to allow for adjustments to reservoir releases, export operations and current Delta standards in such a way that greater proactive responses can be afforded to reduce fish entrainment losses and enhance their survivability in the Delta. Since the operations of such an EWA are intimately tied to the SWP/CVP operations, it is necessary to integrate the EWA and flexible operations into the overall project operations that take into consideration water supply needs, flood control, power scheduling, temperature control and other Delta requirements (Figure 1).

To facilitate the gaming exercise, Russ Brown of Jones and Stokes Associates developed a gaming tool (Daily-Ops). This daily simulation model is consisted of two linked segments--the upstream reservoirs are linked to the Delta portion and the south-of-Delta storage (San Luis Reservoir and ground water storage). Also, incorporated in the Daily-Ops model were the historic salvage densities of a number of target species at SWP and CVP salvage facilities. These densities were used as "fish-triggers" to guide export operations as a means to reduce fish mortality at the pumps.

During the games, other fishery data such as the temporal and geographic distributions, abundance indices and others were introduced to supplement the salvage data. At times, the supplemental fish data suggested that purchasing of water to augment the low San Joaquin flow would be more beneficial than curtailing export pumping. Other times, a combination of both actions was necessary. In addition to adjusting export pumping, the operations of the EWA also involved calling for relaxation of certain Delta standards and capturing water from such relaxation into storage (new storage or existing storage) and reapplying the stored water to protect the fish at some other critical time.

The Need to Improve the Tool-

While the Daily-Ops model was useful for the gaming activities, it was extremely time consuming since all of the operational decisions had to be made manually. This step-by-step interactive mode of modeling was needed for the purpose of learning from the games the rationale behind each operational decision.

Having learned from the games, all the quantifiable or programmable logic and thought processes behind the decisions should be captured and coded into the model. Instead of the time-consuming interactive process, one would then be able to develop the more robust operating strategies and process them through the simulation model in a "batch" mode.

The batch mode of modeling would allow one to explore multitude of operating strategies-- varying operating rules and constraints on the EWA; different threshold levels of fish triggers to guide export operations; when E/I ratios should be relaxed or tightened, and when adjustments to Delta outflow should be made to mimic the more natural pattern.

Furthermore, the proposed operating strategies can be tested under different hydrologic conditions and fish events (high/low salvage densities or some other indices) by simulating them through multiple-year sequences. This is of particular importance when probabilistic assessments of possible outcomes are needed when making decisions under uncertainties.

While the automated version of the simulation model provides speed and efficiency for conducting operational studies, it becomes a necessity for a real-time pilot program in which data and information need to be processed in a timely manner to support real-time decision making.

To accompany the proposed automated simulation/decision-making process, the modeling tool should contain built-in modules to rapidly produce all the key performance measures for evaluating how well or poorly a particular operating strategy (or an operational decision in real time) in achieving the set objectives.

The current version of Daily-Ops offers only a limited set of evaluation criteria. It also lacks the more thorough accounting of the water moving in and out of storage throughout the system for the EWA and the detailed tracking of the impacts and benefits the operations of the EWA have on water supply, power generation and other operational considerations.

Another limitation the current model bears is its computational speed is hampered by the fact that it is written as an application within a spreadsheet application instead of a compiled executable application. Furthermore, any model changes in that format would be a cumbersome task in comparison to one that is designed in a more structured format or in modular object format. Computational expediency is an absolute necessity for a tool to perform in a real-time situation.

Scope of Work-

To allow rapid evaluation of numerous operating strategies for operations planning studies and to support real-time decision-making under uncertainties, the Daily-Ops model needs to improve in the following areas:

(1) computational speed and ease of implementing model changes;

(2) automation of operational decision-making processes;

(3) forecasting both water supply and fishery conditions;

(4) accounting of EWA and SWP/CVP waters as they move across the system;

(5) tracking of impacts and benefits of changed operations (due to EWA) on project water supply and water quality and those project operations may have on environmental objectives;

(6) evaluation of performance measures for the environmental, water supply and water quality objectives;

(7) processing and managing real-time data (hydrologic and fishery indicators); and

(8) graphical user interfaces (both input and output to and from the model) and Internet applicability.

Computational Efficiency

The current model needs to be re-coded using such software platforms as Java, Visual Basic and Visual C++. Using these platforms not only increases the computational speed but also provides a much greater flexibility because the model can then be executed across mixed hardware platforms (PCs, Unix Workstations, etc.). Also, any future modifications to the model itself can be done more efficiently since the model would be object-oriented and modular structured. Furthermore, the use of these software platforms provides the connectivity between model input and output to a database (i.e., Oracle or Microsoft Data Engine) and the Internet.

In addition to handling the high volume of model input and output data, a database is also needed to manage the real-time hydrologic and fishery data (perhaps through the Internet or some telemetry systems). This data management is not only useful in assisting decision-making in terms of system operations but also in tracking how well the system is performing in real-time.

Other software tools that are useful to the proposed modeling development include the Geographic Information System (GIS) and Map Objects. These tools would provide efficient computations of spatial variables.

Automation

Even after the model is reprogrammed using the more efficient software platforms, if the decisions on operating the SWP, CVP and EWA are to be carried out manually, the modeling process would still be extremely time consuming. It is proposed that the decision making process be automated by using some forms of expert system (Figure 2). The proposed expert system would consist of a combination of an heuristic approach that captures the thought process and rationale from the games and certain optimization procedures (Linear, Non-linear and Dynamic Programming).

Water Supply Operations. Decisions involving reservoir and export operations may work well with some forms of Linear Programming in which the objective function can be expressed as the total operating costs (power, water and other O&M items). The corresponding decision variables would be the releases from the reservoirs and export pumping at Banks and Tracy subject to such constraints as physical capacities of the SWP/CVP systems, incoming hydrology, flood control requirements, Delta standards, water demands and many other requirements.

Fish and Environmental Protection. The heuristic approach may be better suited for this purpose. As an example of this approach, the current Daily-Ops model has built in it the fish triggers utilizing the salvage data from the SWP and CVP facilities. These triggers are based on the three-day moving average of salvage per export quantities (salvage densities) of Delta Smelt, Salmon, Splittail, Steelhead and Striped Bass. If either the rate of increase or the observed salvage densities exceeded the preset threshold levels, exports would be reduced in some prescribed inverse proportions (Figure 3).

During the DNCT games, other fishery data were brought in to supplement the salvage data to aid operational decisions. For instance, the IEP real-time monitoring of distribution of Delta Smelt was used to provide earlier warning signals (Figure 4) and the observed Chinook salvage plots (Figure 5) with fork length and geographic distribution information were used to differentiate the types (winter run or spring run) and origin (Sacramento versus San Joaquin) of the Salmon that ended up at the salvage facilities.

To provide an example of how these supplemental data can be automated into the decision-making process, consider the movement of the centroid of the geographic distribution of the particular species in question (see Figure 4 for reference). The size of the distribution and the speed vector (magnitude and direction) of the centroid may guide decisions on decreasing or increasing the export pumping, and making releases from in-Delta storage or upstream reservoirs to augment low-flow conditions.

Below are excerpts from the gaming notes capturing the various EWA actions (operational decisions) that affected project operations:

- Used fish triggers to reduce exports early.
- Let VAMP occur (5 wks); ramped up exports to full pumping in June and July.
- Could start putting water into groundwater.
- Pumping should be only 1,500 (pumping limit) for VAMP (second half of April; first half of May). Keep at 1,500 for the whole period.
- Action: maintain pumping at 7 kcfs for the entire month. Spring run yearlings and other similar-sized salmon migrating through the delta; action taken to improve in-delta conditions related to survival.

- Fish densities are rising; assume that the salmon present are progeny of previous fall's winter run spawning.
- Fish Decision: Restrict pumping to 4 kcfs for the month of March. (Cost will be less since San Luis is nearly full, and will probably spill).
- EWA has options on 1100 KAF to spend on the San Joaquin side
- EWA cost is 60 KAF for restrictions in March.
- Add 2,000 cfs to SJR flow for the last 2 weeks of March.
- Use 60 KAF out of reservoir storage.
- Purchase 100 KAF in options, March. Release 60 KAF of this to increase SJR instream flows.
- Could back up 60 KAF in Folsom; there would be an instream flow consequence; could result in a stranding problem without appropriate ramping. Could go for about half of the amount, since the Folsom storage level is so low, and the streamflow situation is not good. Could adjust instream flow requirement to 1,000 cfs, moving 30 KAF back up into Folsom. This would be half of the EWA releases in the San Joaquin. EWA action: Do it.
- Fish status: Very poor FMWT index for delta smelt. No salmon in Oct or Nov. Salmon show up in mid-December.
- Release American River water to downstream areas by watching weather and water temperatures (lower temperatures usually start in November). Jump to next AFRP step in November.
- Relax E/I in December? There is precedent. Do it for first week in December; 200 cfs for the month (average). Water consequence is a very small degradation in water quality (chlorides).
- Transfer 30 KAF into San Luis.
- Salmon (spring run yearlings; juvenile winter run) present in the delta in last two weeks of December: Reduce exports to 8,000 cfs for the second half (extend into and through January). Cost to EWA = 60,000.
- Maintain export levels at 8,000 cfs through the month. Very low FMWT index for delta smelt in the previous fall; spring run and winter run salmon present.
- Oroville, Shasta, etc. getting quite full. All spill at the end of January.
- Exercise EWA and increase American River flows by 2,000 cfs (250 higher than AFRP) and extend through January. Add to EWA debt.
- Debt from Folsom releases is 250 cfs for about a week (240 KAF debt). Confidence that Folsom will spill.

Using these actions and the rationale behind them, conditional logic can be built to automate the decisions in the model. Wherever possible, functional forms of the decision

should be use. For example, export reduction or San Joaquin flow augmentation should be a function (at least in block structure) of the magnitude of fish present and the hydrodynamic conditions (relevant to calculating the zone of influence of the pumps).

Water Quality Enhancement. Initial thinking points at two possible methods to incorporate a mechanism into the model for water quality improvements. One is to set flow targets at strategic locations in the Delta (Delta outflow, San Joaquin, Rio Vista, etc.) and for selected time periods. Using flow targets, automation of the decision process can utilize the more structured approach--i.e., Linear Programming.

These flow targets can be set by observing the historic data (Figures 6 and 7) and the analytical results of a hydrodynamic model study (Figure 8). For instance, on average, historic data suggest that the best quality (in terms of TDS) at the export pumps occur during the period from about May through July. This is confirmed by the hydrodynamic analysis that after July, seawater intrusion would bring up the TDS concentration to a peak in October and slowly cease to a low point in May. At the export area of Contra Costa Water District, in addition to sea-water intrusion, another component of salt-loading of concern is the agricultural drainage water that is most evident from February through April. Not only there exists differences in terms of geographic locations for a given chemical constituent; there exists timing differentials at a given location for different chemical constituents. Observing Figure 8, the worst water quality in terms of TDS occurs in about October and November; while the worst in terms of DOC occurs in about February and March.

Armed with this information, project operational targets that can be set may include: (1) Delta Cross Channel (DCC) gate to increase the flow into the interior Delta; (2) Delta outflow targets to reduce high sea-water intrusion; and (3) export targets to reduce exporting poorer quality water.

The key problem with setting flow targets in this manner is that real-time deviation from average conditions would not be reflected in the model and the consequential operating decisions also would not be consistent with actual conditions.

The other approach is to use the water quality triggers (in similar manner as the fish triggers described above) where real-time water quality data would be used instead of preset flow targets. These data would also be supplemented by the understanding of the hydrodynamic interactions. Actions would be taken may include letting go of first-storm events, opening of the DCC gate, increasing Delta outflow (purchased water or additional reservoir releases), and reducing exports when TDS or DOC exceeds the threshold level.

Forecasts

Essential to any decision support system is the ability to forecast. The time horizon and accuracy of the forecasts depend on their intended use. For water supply operations, the time horizon may range from a few days (to guide daily operations) to a year (for annual operations planning).

For the purpose of adjusting project operations to real-time fish occurrences at certain Delta locations including the project pumps, one to three-month forecasting horizon would be sufficient to guide weekly or daily operations of the EWA along with the SWP/CVP.

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Water Supply Forecasts. The Department of Water Resources and the US Bureau of Reclamation, through the Divisions of Operations and Maintenance, Flood Management and others have long established such programs as the California Cooperative Snow Survey, California Data Exchange Center and California Environmental Resources Evaluation System to provide detailed river, flood, weather and water supply information for operations and planning purposes. In addition, the National Weather Service Climate Prediction Center also works with the DWR to provide temperature and precipitation forecasts. Also, forecasts on water conditions are available from private companies whose costs and accuracy may even be more competitive to the sources cited above.

Examples of the types of information obtainable from the various forecasting sources are given in Table 1 and Figure 9. Clearly, there is no need to exert any additional effort to conduct water supply/hydrologic forecasts for the purpose of operating the EWA. However, there is a need to create a database to manage the water supply forecast information so that the proposed decision support system can process this information along with other data such as geographic and temporal distribution of fish occurrences, power scheduling, water demands, Delta standards and other operational requirements.

Fish Distribution Forecasts. As a first order of magnitude forecast, simple projections based on the real-time IEP or CMARP monitoring data may be used. In that regard, additional work may be required to develop certain statistical indices using historic fish data along with appropriate hydrodynamic parameters--stage, flow and salinity. If such a statistical model already exists, we may need to calibrate it with the real-time data as an on-going refinement process.

Water Quality Forecasts. Using real-time water quality data (MWQI data, Figure 10), either simple statistical projections can be computed or the more sophisticated computational processes such as the one being researched by the Department of Water Resources--Artificial Neuron Network (ANN).

The goal of introducing forecasts into the decision-making process is to allow for calculation of risks when making decisions under uncertainties. The modeling results would provide probabilistic as opposed to absolute assessments of reductions in fish entrainment losses, water supply yield and water quality improvements.

Accounting and Tracking

Operations of the Projects as well as the EWA depend heavily on the system conditions (storage and conveyance capacities) and the status of the various assets (monetary and water). Also operations decisions hinge on what and the level of benefits to be achieved and probable negative impacts that may incur.

Therefore, it is necessary for the proposed model to record and account for the various system conditions and assets. It may even be necessary to account for how the Projects would have been operated if the EWA were not in place. This would then be the basis for comparison of the benefits and impacts due to operating the EWA. For instance, the power generation and consumption and the associated costs of the SWP/CVP operations as they can be significantly affected by the activities of the EWA.

A time shift in reservoir releases or export pumping can affect the costs of operations depending on the price of power that varies with the seasons and time of day.

Similarly, the actions of an EWA can affect the Project operations toward regulatory compliance for water quality, and water rights. The system would need to track the potential shift in such regulatory parameters as X2 position, or the added/saved cost of water towards meeting the water quality objectives. Likely a specific module is needed to estimate these effects throughout the year. These effects can then be quantified and charged or credited appropriately.

Also, it is conceivable that the EWA could affect the determination of basin conditions per the COA, such as "balanced" or "excess", which guide the Project's sharing formulas for water releases and exports. Every aspect of the EWA's actions will need to be recorded and tracked to balance the separate responsibilities or obligations between the SWP and CVP according to the COA. It also may prove very useful to have a reporting element designed to expedite the work with the DWR and USBR's accounting groups on the Projects.

Other accounting and tracking considerations raised at the DNCT games and observations made by Dave Fullerton (see DF's 6/7/1999 issue papers):

- sharing formula for existing and new storage and conveyance and pumping capacities;
- cost savings from virtual transfers;
- responsibility issues with tight X2 and E/I margins;
- impacts of EWA's carryover debts;
- benefits from synergetic actions (e.g., ERP type instream flow benefits, water quality improvements in San Luis, etc.);
- potential tax on EWA releases from Shasta--carriage losses (20% combination of carriage and conveyance loss); and
- effects on Shasta cold-water pool.

The accounting and tracking modules of the model should be designed with the flexibility that users could specify the cost/benefit sharing formula (between Projects and EWA). In this manner, the sharing formula can be tested under varying hydrologic and fishery conditions.

Performance Measures

An essential feature of the proposed tool is the rapid calculation of a set of performance measures for a given operating decision. This high-speed assessment of how well the system performs in achieving the various objectives would allow the operators to consider a large number of options before making the final decision or to select an option that provides the most probable (hopefully also favorable) outcome. Below are some ideas on the types of performance measures that should be included in the tool:

For fish/wildlife/ecosystem:

(1) Percent reduction in fish mortality of selected species at the pumps.

(2) Timeliness in affecting operational changes (DCC closures, export reductions, low-flow augmentation, etc.).
(3) Safety margins (buffers) that an operating strategy or a real-time operations decision might have created for the Delta outflow, X2, E/I ratios, Rio Vista Flow, Vernalis Flow and other Delta standards and requirements.
(4) Temperature profiles relative to desirable targets at key locations.
(5) Instream flows to achieving ERP objectives.

Look for opportunities to shifting the buffers to enhance satisfaction of Delta standards during critical time periods as reflected by real-time data.

For Agr. And M&I water users:
(6) Water quality for Agr. and M&I water users (both magnitude and timing relative to some preferred targets).
(7) Water supply for the SWP/CVP projects (actual amount and timing in comparison to demand requests and to maximum deliverable quantities).
(8) Reservoir conditions relative to water supply operational targets.

Samples of the above-described performance measures are given in Figures 11-16.

Designing Team

DNCT members, additional agency and stakeholder biologists, project operators, engineers/modelers and consultants.

Time Schedule and Budget

The proposed work should be staged to follow the priority set (by DNCT) to assist early implementation of the EWA. Below are tasks listed by category (not by priority) and approximate person-months for their completion:

Task	Description	Person-Month
1	**Re-coding Delta and Reservoir Models**	4
1a	**Verification of re-coded model**	2
1b	**Data Compilation**	2
1c	**Accounting and Tracking**	1
2	**Decision Automation/Expert System**	4
3	**Performance Measures**	3
4	**Forecasting Modules**	2
5	**Database**	4
6	**GIS/Map Objects**	3
	Total:	**25**

Some tasks may overlap and require completion of the others before they can proceed and others are quite independent.

Table 1
Sample of Available Water Supply Information

WSUP (06/07/99 1620)

DEPARTMENT OF WATER RESOURCES
California Cooperative Snow Surveys

WEEKLY WATER *SUPPLY CONDITIONS*
As of Jun 7, 1999

PRECIPITATION, Northern Sierra 8-station index:
Mt. Shasta City, Shasta Dam, Brush Creek, Mineral R.S., Quincy, *Sierraville R.S., Blue Canyon, Pacific House.*

PREVIOUS MONTHS' DATA	Current Total	1922-98 Average	% of Average
October:	1.5"	3.0	50%
November:	12.7"	6.3	202%
December:	4.7"	8.4	56%
January:	10.0"	9.0	111%
February:	15.1"	8.0	189%
March:	5.5"	6.9	80%
April:	3.2"	3.9	82%
May:	0.9"	2.1	43%
June:		1.0	
July:		0.2	
August:		0.3	
September:		0.9	
CURRENT MONTH			
June 1 to June 7:	0.5"	0.2"	
June historical average:		1.0"	50%
PRECIPITATION SUMMARY			
Water year to date total:	54.1"	47.8"	113%
Water Year historical average:		50.0"	108%

SNOWPACK WATER CONTENT *(Sierra snow sensors) percent of average to date:*

Northern	Central	Southern	Statewide

Percentages for the date are not available this late in the water year

RESERVOIR STORAGE *(at 2400 hours) in thousands of acre-feet:*

Name	Capacity	6/6/98 Storage	6/6/99 Storage	Net Change	% of Capacity
Trinity Lake	2448	2305	2389	+84	98%
Shasta Lake	4552	4454	4294	-160	94%
Lake Oroville	3538	3362	3470	+108	98%
New Bullards Bar Res.	966	854	909	+55	94%
Folsom Lake	977	774	919	+145	94%
New Melones Reservoir	2420	2148	2030	-118	84%
San Luis Reservoir	2039	2028	1401	-627	69%
Pine Flat Reservoir	1000	698	881	+183	88%

Figure 1

Integration of EWA into CVP/ SWP Systems Operations

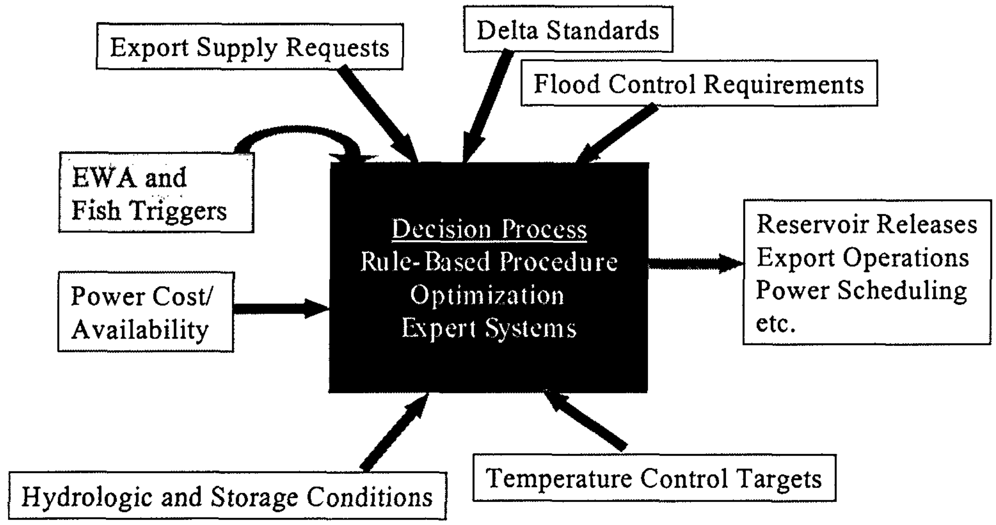


Figure 2

Operations Decision Support System

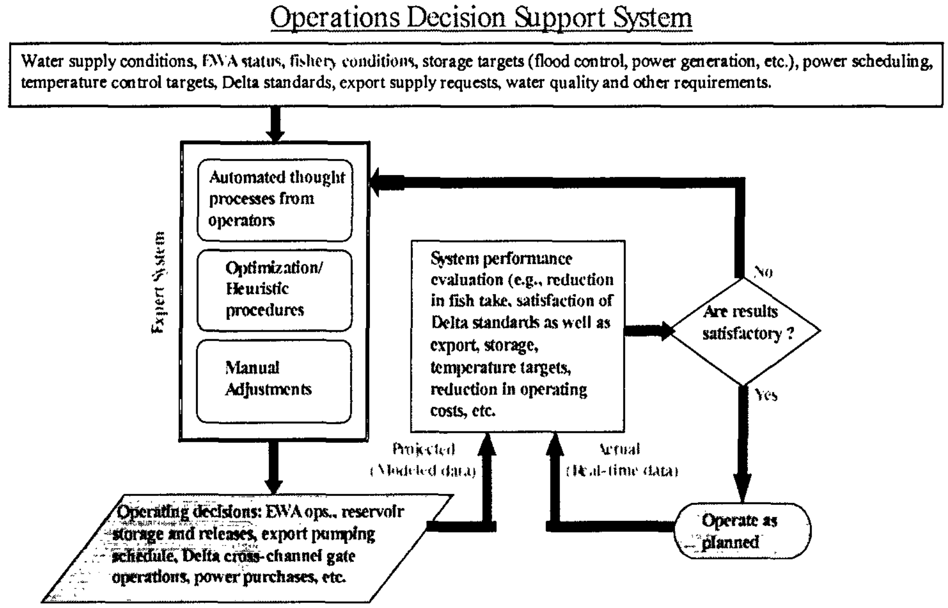
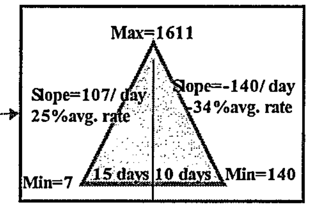
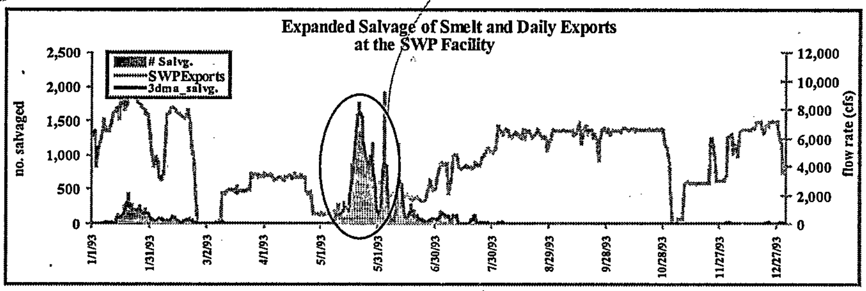


Figure 3

Fish Triggers

- The contemporaneous salvage count*
- The rate of change (increase or decrease) in the salvage count (slope on the curve)
- The duration (uprising and recessing limbs)





* If there are data reflecting the timing and quantity of fish arriving at the intake that are relatively independent of exports, they can be used in place or in support of the salvage data.

Figure 4--Delta Smelt Distribution

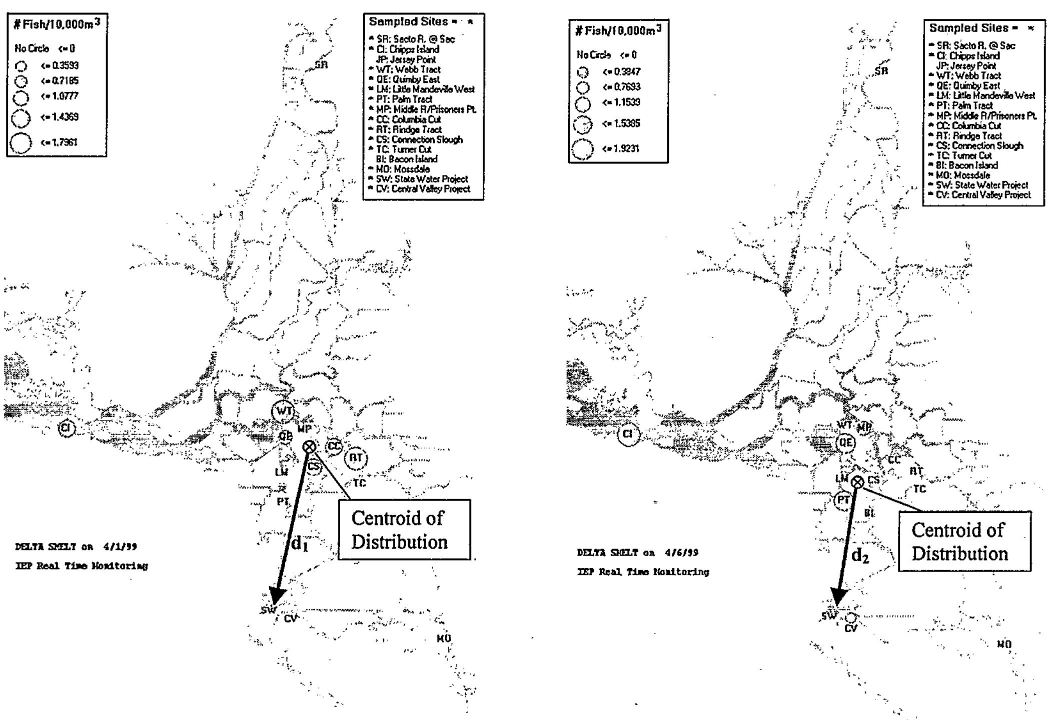


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Figure 5

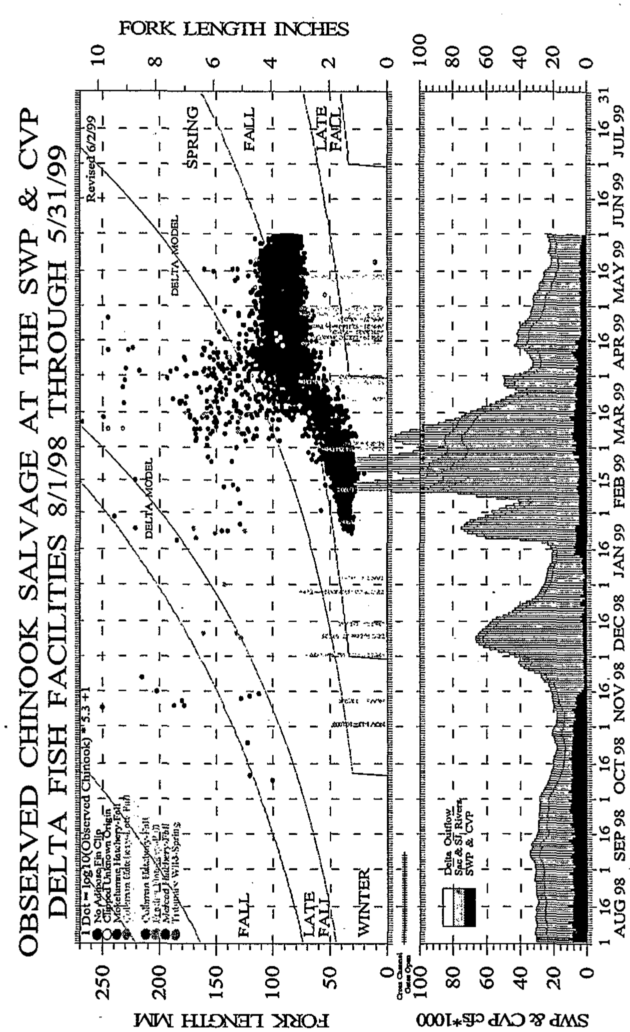
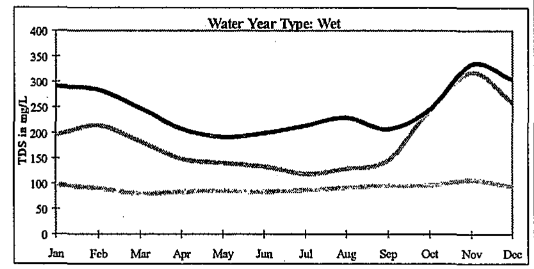
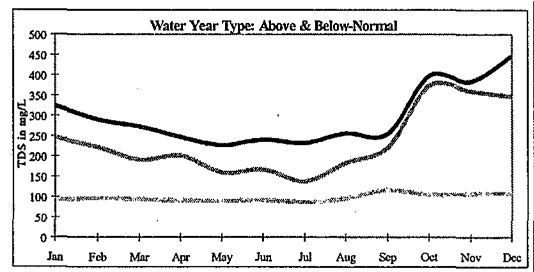


Figure 6-

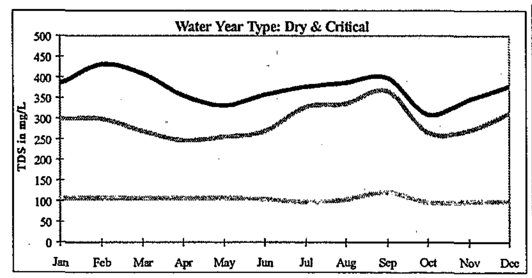
Monthly Average of Observed TDS at Selected Stations in the Delta



Wet	Greene's Ldg	Clifton Ct.	DMC
Jan	98	195	291
Feb	91	214	284
Mar	80	183	248
Apr	83	148	208
May	85	140	192
Jun	84	133	199
Jul	87	118	213
Aug	92	129	230
Sep	96	145	207
Oct	96	243	246
Nov	106	318	334
Dec	94	259	304
Ann-Avg:	91	185	246



A/B Normal	Greene's Ldg	Clifton Ct.	DMC
Jan	92	246	324
Feb	96	221	290
Mar	93	191	273
Apr	91	201	247
May	89	159	227
Jun	92	167	240
Jul	87	138	232
Aug	96	183	256
Sep	117	221	255
Oct	104	373	397
Nov	107	359	383
Dec	109	347	447
Ann-Avg:	98	234	298



Dry&Critical	Greene's Ldg	Clifton Ct.	DMC
Jan	106	299	384
Feb	108	299	431
Mar	106	268	409
Apr	106	247	356
May	107	255	331
Jun	105	268	357
Jul	97	328	377
Aug	104	335	387
Sep	120	366	398
Oct	96	265	309
Nov	98	270	345
Dec	99	312	378
Ann-Avg:	104	293	372

Sacramento River at Greene's Landing
Clifton Court Intake
Delta Mandota Canal Intake

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Figure 7- Historic Data from MWQI

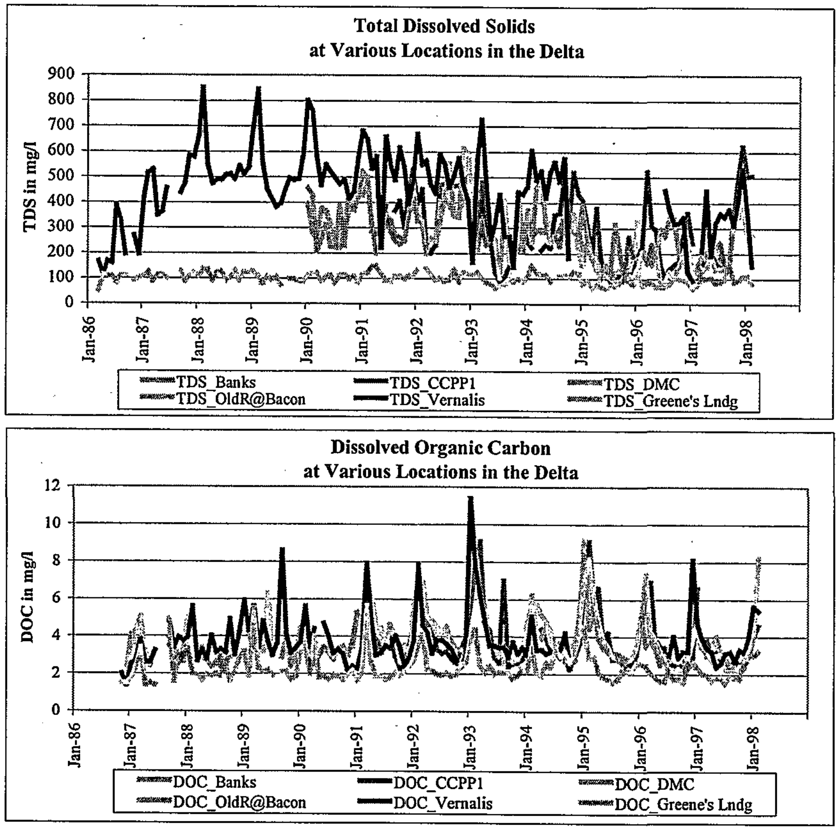


Figure 8-- Results of Hydrodynamic Modeling Analysis

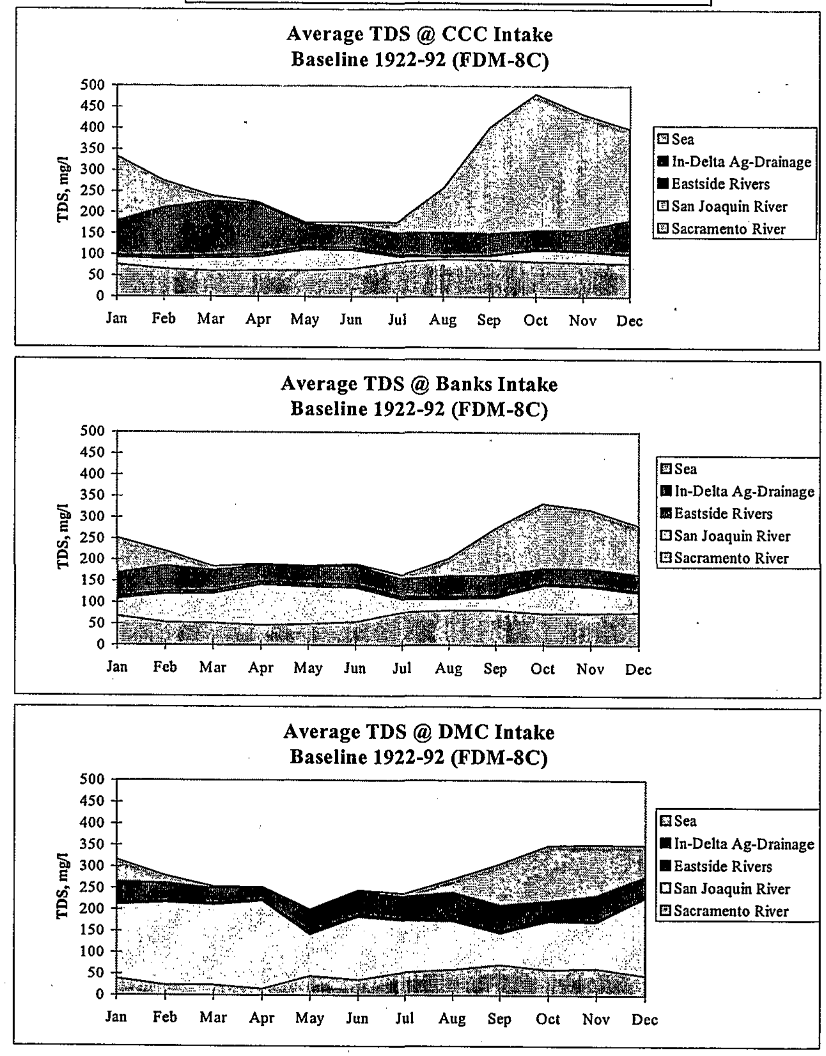


Figure 9- National Weather Service Climate Prediction Center's Forecasts

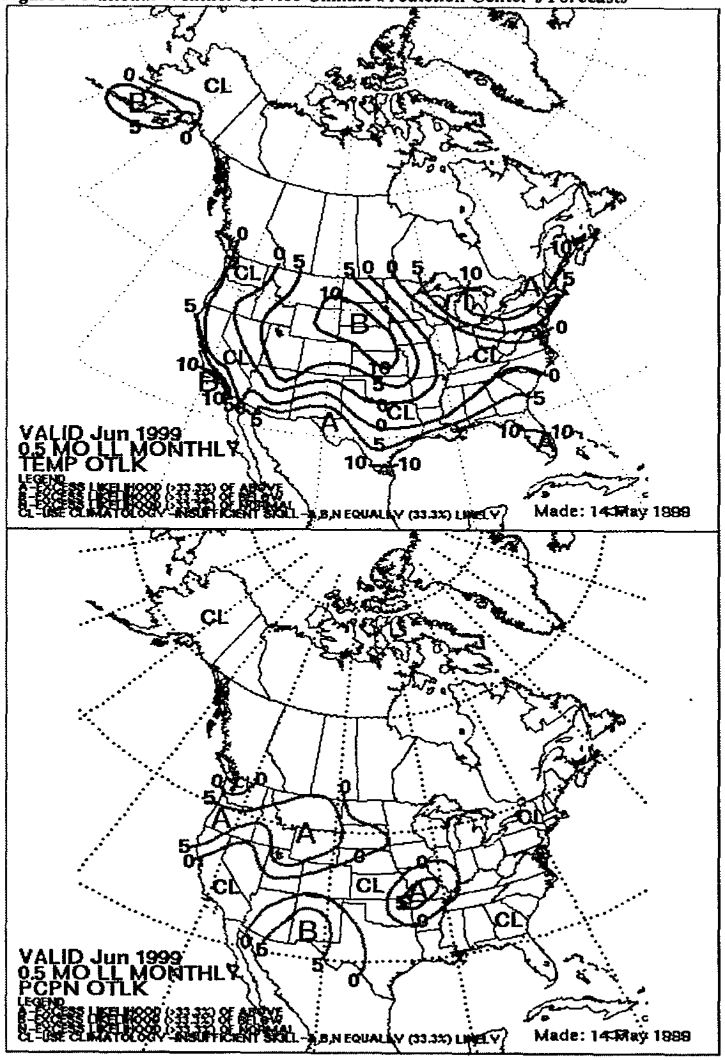


Figure 10- MWQI Water Quality Monitoring Stations

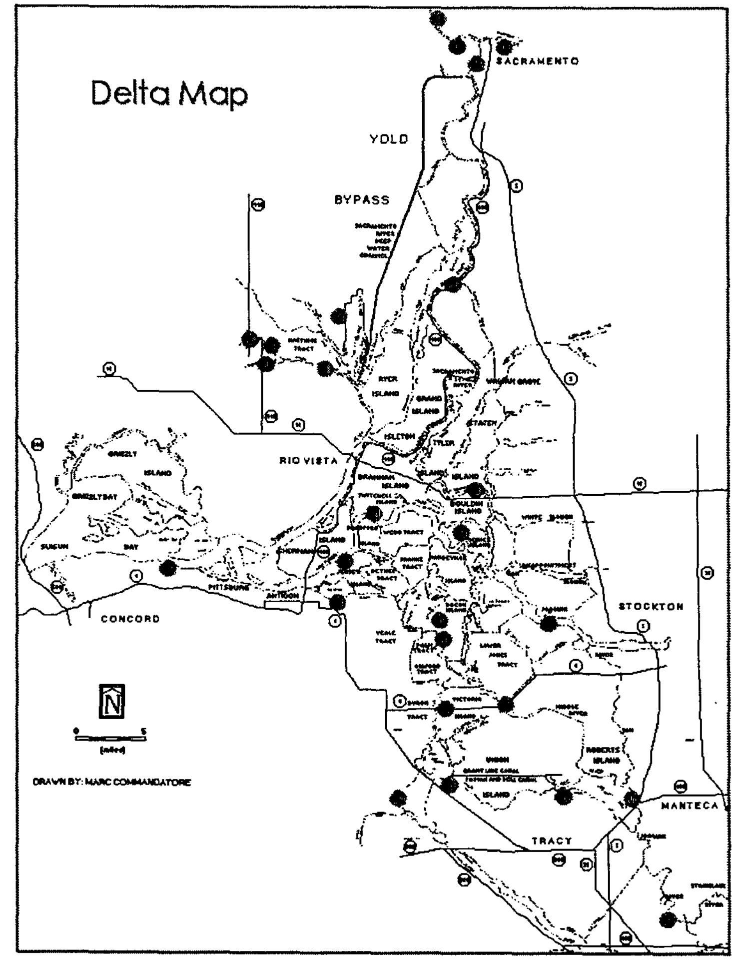
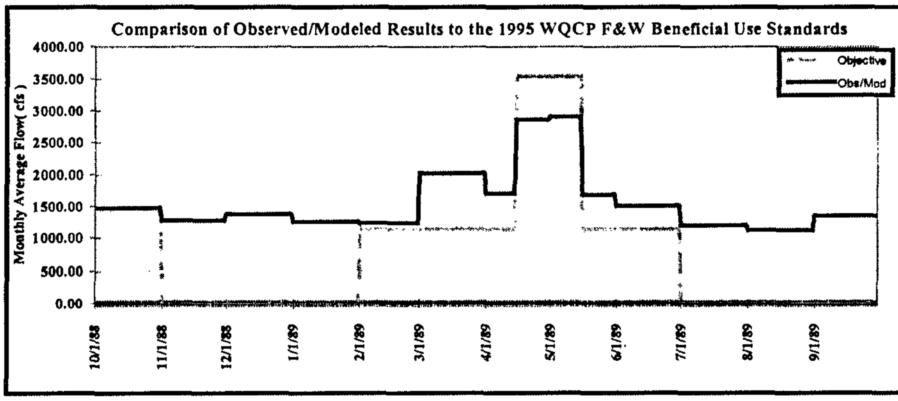


Figure 11

Case: **Using fish triggers to modify export operations**

Station: C10FW5	Loc/Desc:	San Joaquin River at Airport Way Bridge, Vernalis	1989	WYType: Cri

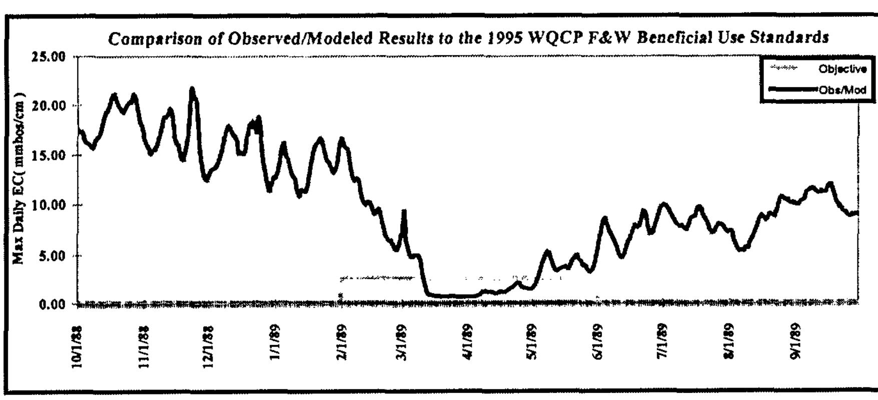


Measures of obj. satisfaction/violation	Freq. count (days)	Value*-days	Max-Diff	Avg-Diff	Min-Diff
Objective satisfaction count:	150				
Value* (below obj. level):		0.00	881.68	0.00	0.00
No. of objective violations:	31				
Value* (above obj. level):		0.00	-677.02	0.00	-630.92
Time periods required :	181				
% of time standards are met	83%				
* Values used are: Monthly Average Flow(cfs)					

Figure 12

Case: **Using fish triggers to modify export operations**

Station: C14FW8	Loc/Desc:	Roe Island (Port Chicago)	1989	WYType: Dry



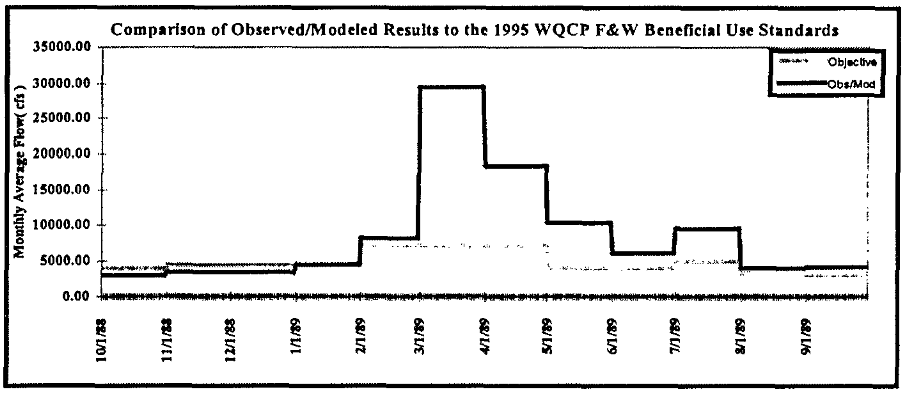
Measures of obj satisfaction/violation	Freq. count (days)	Value*-days	Max-Diff	Avg-Diff	Min-Diff
Objective satisfaction count:	34				
Value* (below obj. level):		-49.50	-1.97	-1.46	0.00
No. of objective violations:	21				
Value* (above obj. level):		60.73	6.53	2.89	0.00
Time periods required :	55				
% of time standards are met	62%				
* Values used are: Max Daily EC(mmhos/cm)					

D-060588

Figure 13

Case: Using fish triggers to modify export operations

Station: NDOIFW5	Loc/Desc:	Delta Outflow	1989	WYType: Dry



Measures of obj. satisfaction/violation	Freq. count (days)	Value*-days	Max-Diff	Avg-Diff	Min-Diff
Objective satisfaction count:	273				
Value* (below obj. level):		0.00	22385.62	0.00	0.00
No. of objective violations:	92				
Value* (above obj. level):		0.00	-1007.53	0.00	-1003.36
Time periods required :	365				
% of time standards are met	75%				
* Values used are: Monthly Average Flow(cfs)					

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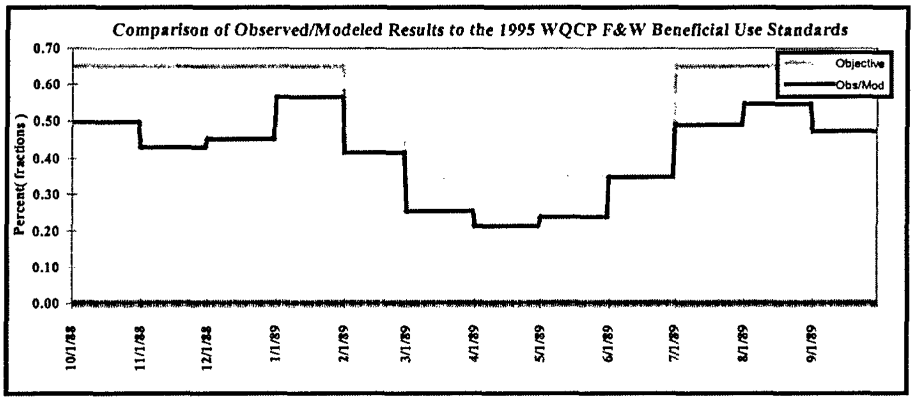
Figure 14

Case: Using fish triggers to modify export operations

Station: EIFW6	Loc/Desc:	Export/Inflow Ratio	1989	WYType: Dry



Measures of obj. satisfaction/violation	Freq. count (days)	Value*-days	Max-Diff	Avg-Diff	Min-Diff
Objective satisfaction count:	365				
Value* (below obj. level):		-45.29	-0.22	-0.12	0.00
No. of objective violations:	0				
Value* (above obj. level):		0.00	0.00	0.00	0.00
Time periods required :	365				
% of time standards are met	100%				
* Values used are: Percent(fractions)					

Figure 15- Forecasted Reservoir Conditions (DWR Operations)

Preliminary Forecast of 1997 SWP Operations | *Preliminary Forecast of 1997 CVP & SWP Operations*

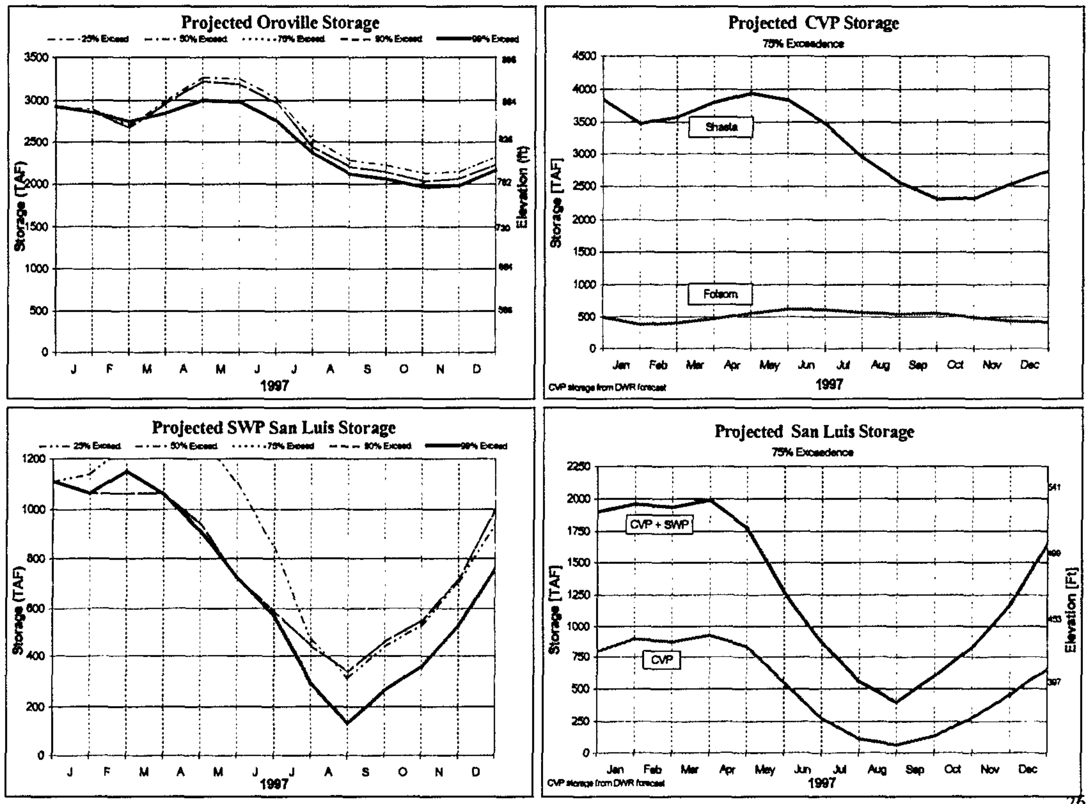


Figure 16- Projected SWP/CVP Exports